Update / Le Point

Economics of hypertension control*

World Hypertension League[1]

This paper summarizes the key aspects of the problem of estimating the economic burden of hypertension and hypertension-related disease, the use of economic models, and the opportunities for containing the costs. More information is needed on the population-attributable risk of hypertension in various countries, which is indispensable to estimate the part of hypertension in the burden of stroke and heart disease. The population and high-risk approaches to hypertension control also have economic consequences, which may vary in different societies and must be assessed to ensure proper allocation of resources. Cost-containment can be achieved by more selective diagnostic investigations and by opting for cheaper drugs, though the choice of treatment is difficult owing to uncertainties in the quality-of-life estimates.

Introduction

The fact that high blood pressure is relatively common in developed countries, together with the results of treatment in randomized trials (*1*), has led to a rapid growth in antihypertensive drug treatment with an increasing trend for more expensive drugs to be prescribed. For example, there was in France a sixfold increase in the diagnosis of hypertension between 1970 and 1990, and a tenfold increase in antihypertensive medication expenditure (*2*). As developing countries undergo the transition to the disease pattern of developed countries, cardiovascular diseases are becoming proportionately more important as a cause of morbidity and mortality, and the control of hypertension will become an issue in many countries. The increasing cost due to or relating to hypertension is thus a reality so that, even in the most affluent countries, owing to resource constraints the strategies for hypertension control have to compete with other health care interventions and other needs of society.

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[1] The World Hypertension League is an association of antihypertensive leagues, hypertension societies, committees and other national bodies whose aim is to control hypertension in populations. The present document was prepared by Dr A. Fletcher, Department of Epidemiology and Population Sciences, London School of Hygiene and Tropical Medicine, University of London, whose work is gratefully acknowleged. It is one of a series of statements on topics that are of practical importance for the management of hypertension, addressed to practising physicians. Like the earlier papers, the text has been repeatedly and extensively discussed by representatives of the League's member organizations and accepted as a consensus document.

In May 1994 the regular membership of the World Hypertension League comprised the following organizations: All India Heart Foundation; Argentine Society of Hypertension; Arterial Hypertension Society of Mexico; Austrian Hypertension Society (Austrian Hypertension League); Hypertension Committee of National Heart Foundation of Bangladesh, Belgian Hypertension Committee; Brazilian Society of Hypertension; British Hypertension Society; Bulgarian Hypertension League; Canadian Coalition for High Blood Pressure Prevention and Control; Chilean Foundation of Hypertension; Chinese Hypertension League; Costa Rican Hypertension League; Council for High Blood Pressure of the Irish Heart Foundation; Croatian Society of Hypertension; Czech Working Group for Hypertension at the Czech Cardiology Society; Danish Society of Hypertension; Dutch Hypertension Society; Finnish Hypertension Society; French National Committee for the Control of Arterial Hypertension; German Hypertension League; Heart Foundation of Latvia; Hellenic Society of Hypertension; Hungarian Society of Hypertension; Inter-American Society of Hypertension; Israel Hypertension Society; Italian League against Hypertension; Japanese Heart Foundation; Lebanese Hypertension League; Lithuanian Hypertension League; National High Blood Pressure Education Program (USA); National League for the Control of Cardiovascular Disease (Morocco); Nigerian Hypertension Society; Norwegian Society of Hypertension; Pan African Society of Hypertension (PASCAR); Polish Society of Hypertension; Portuguese Hypertension Association; Senegal Heart and Hypertension Foundation; Slovak Hypertension Society; Slovene Medical Association — Hypertension Society; Southern African Hypertension Society; Spanish League against Hypertension; Swedish Hypertension Society; Swiss Association against High Blood Pressure; Turkish Association for Hypertension Control; Uruguayan Hypertension Committee; Venezuelan Foundation against Ischaemic Heart Disease and Hypertension; Zaire Hypertension League.

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Concerned with these issues, the World Hypertension League convened an International Workshop on the Economics of Hypertension Control in Barcelona, Spain, in September 1991, details of which with recommendations have been published (*3*). This paper summarizes the key aspects of the Workshop proceedings, which include estimation of the economic burden of hypertension and hypertension-related disease, the use of economic models to establish public health strategies for the control of hypertension, and identification of opportunities for cost containment.

Burden of hypertension and hypertension-related disease

The economic burden of disease has traditionally been measured in terms of (i) the direct costs of health care and other resources used to treat the disease, (ii) the indirect costs or economic consequences of the illness, such as loss of income, and (iii) intangible costs relating to the levels of impairment or reduction in the quality of life of the individual (*4*). The economic burden of hypertension is considerable because it includes not only the costs arising from the treatment of hypertension itself, but the burden of hypertension-related disease, the best-documented example of which is stroke and coronary heart disease (CHD).

The population-attributable risk (PAR) is a method of expressing the extent to which the burden of disease in a population results from a particular risk factor. Thus, theoretically a PAR of 100% would mean that all the disease burden was attributable to the risk factor, and 0% would mean that none of the burden was attributable to the risk factor. The PAR in our present analysis depends on the definition and prevalence of hypertension in a population, and the risk associated with that particular blood pressure level derived from prospective studies (*5*). In a typical developed country, such as Australia, the PAR for hypertension (38% prevalence of diastolic blood pressure (DBP) of ≥90% mmHg, based on a single reading) has been estimated as 36% for stroke and 22% for CHD (*6*). PARs for DBPs of ≥95 mmHg (20% prevalence) were 30% for stroke and 18% for CHD, and for DBPs of ≥100 mmHg (11% prevalence) they were 22% for stroke and 13% for CHD. Moreover, it is likely that the PARs for stroke and CHD underestimate the burden of disease which is related to hypertension since vascular dementia, heart failure, peripheral vascular disease, and end-stage renal failure are also, to some extent, the consequence of a raised blood pressure.

Data from developing countries indicate a high prevalence of hypertension in many communities, e.g., reports from urban areas in Brazil and Thailand of DBP of ≥95 mmHg in 20% of the surveyed population (*7, 8*). As more precise information on stroke and CHD rates becomes available from countries, the estimation of the PAR due to hypertension and the relative importance of CHD and stroke as causes of morbidity and mortality will assist the debate on determining health priorities in those countries.

Direct economic costs

In developed countries health care utilization statistics indicate a considerable economic burden from cardiovascular diseases (CVD), including hypertension. For example, the United Kingdom is in the middle range among developed countries in the proportion of GNP spent on health care (around 7%) (*9*). Diseases of the circulatory system account for 16% of all hospital inpatient days, 7% of all outpatient referrals, and 9% of general practitioner consultation rates, representing approximately 10% of the total National Service budget and 0.8% of GNP (*9*). Higher figures (1.25% of GNP) have been reported from the USA for the direct costs of circulatory diseases (*10*).

Direct health care costs of hypertension are mainly due to family doctor consultations and drug treatment. In the United Kingdom, 4% of the total population consult their general practitioner at least once for uncomplicated hypertension in any year. Consultations for hypertension represent 4% of all general practice consultations at all ages, and nearly a half of all consultations for circulatory disease. However, health care expenditure from family practitioner services in the United Kingdom accounts for less than 10% of the National Health Service gross expenditure. The proportion of GNP due to hypertension consultations is less than 0.04% and for consultations for all cardiovascular diseases is 0.09%. Cardiovascular drugs account for 17% of all drug prescriptions in the United Kingdom, and antihypertensives and diuretics (some of which are given for other indications) for 8%. The total pharmaceutical expenditure is 10% of all health care costs, and hence 0.7% of GNP. The proportion of GNP due to cardiovascular drugs is 0.2%, and that due to antihypertensives (including diuretics) probably around 0.05%. Thus, hypertension and antihypertensives account for less than 0.1% of GNP, and contribute to 10% of health care expenditure on CVD. This is because the greatest costs are incurred in hospital services, and are mainly accounted for by hypertension-related diseases rather than hypertension *per se*.

Much of the burden of circulatory disease falls on the over-65s, both in relative and absolute terms. In the United Kingdom the highest admission rates to hospital are for circulatory diseases in the over-65s, ranging from 5% of those aged 65–74 years in the population to 10% of all aged 85+, and accounting for nearly 60% of all acute hospital admissions for circulatory disease (*11*). Circulatory diseases constitute the main reason for general practitioner consultation of the over-65s, with 36% of the 65–74-year-olds and 44% of the over-75s consulting at least once for this reason and accounting for 70% of all consultations for circulatory disease (*12*). Approximately half the consultations in the 65–74 years age group are for uncomplicated hypertension, while in the over-75s heart failure and hypertension equally account for half the consultations. The elderly are also the highest consumers of medicines. Surveys of prescription use in the elderly in the United Kingdom found that 25% of 65–74-year-olds and nearly 40% of the over-75s were taking diuretics; comparable figures for beta-blockers and vasodilators in the over-65s were 15% and 7% (*13*).

Other health care costs result from increasing disability in elderly subjects, a part of which is due to cardiovascular diseases. An Australian survey found that nearly 20% of disability in 65–74-year-olds was due to circulatory diseases; for the over-75s the figure will be even greater (*6*). One study reported that stroke accounted for 17% of disabilities in the 65–74 years age group and 13% of those aged over 75 years (*14*). Some studies have estimated that between 8% and 20% of direct costs of stroke are due to non-hospital costs, such as home helps and domiciliary nurses (*15–17*). Extreme disablement will also entail long-term institutional care costs, estimated at around 25–30% of all direct stroke costs in the above studies. A U.S. survey of long-term residential institutions found that 38% of residents had heart trouble, while hypertension, stroke, and diabetes each affected around 10%. Most residents needed a high level of care; less than 10% were independent in basic self-care activities. If vascular dementia is included in the economic burden of hypertension-related disease, then there are considerable extra costs of CVD health care, primarily due to institutionalization. In the United Kingdom, 0.4% of subjects aged over 75 years are admitted to a mental hospital each year for dementia, with vascular dementia probably representing one third (*18*).

At present, there is only a small body of research on the economic consequences of cardiovascular disease in developing countries. Noncommunicable diseases (primarily CVD) represent the major cause for hospital admissions and outpatient attendance in both middle-aged and elderly people in many developing countries (*19*).

Indirect costs

Indirect costs include loss of productivity and earnings and disability pensions in the working population. Hypertension accounts for few direct costs. Most indirect costs are for hypertension-related disease, especially ischaemic heart disease (IHD). In developed countries, circulatory diseases account for 18% of premature years of life lost, the greatest burden of which is due to IHD in men (20% of premature mortality in men). Stroke accounts for 4% of premature mortality. Since most CVD occurs in elderly people the indirect costs due to earning losses are not substantial. However, other indirect costs are important. Nissinen estimated that CVD accounted for 25% of all disability payments in Finland in 1972 (*20*); similar figures were reported for Spain (*21*).

Other indirect costs of CVD in the elderly may be incurred by other family members who give up or reduce their work to care for an elderly person. The care provided by family members has rarely been costed but obviously represents a considerable saving to public expenditure.

Data on the indirect economic consequences of ill health in developing countries are scanty. In Brazil, CVD accounted for 17% of the total premature mortality in men and 27% in women, with higher proportions in the most developed parts of the country compared to the least developed (*22*). A small number of studies in younger adults in developing countries have suggested that the household compensates for the death or illness of a family member by increasing their work load. Land and livestock sales have been described as methods to raise cash to pay for medical care (*19*).

Intangible costs

Intangible costs range from relatively small adverse effects on the quality of life resulting from hypertension treatment, to major impairments due to hypertension-related disease. Studies that measured the quality of life while on antihypertensive treatments, principally in comparison with an angiotensin-converting enzyme (ACE) inhibitor, indicate that centrally-acting drugs and certain beta-blockers such as propranolol do appear to reduce well-being by a small amount, primarily through depressing the mood and cognition. ACE inhibitors offer advantages over these drugs, but in general are similar to drugs such as atenolol. Far less is known about the

quality of life of persons on diuretics although there is consistent evidence that some diuretics, such as chlorthalidone and the thiazides, increase the incidence of impotence, with rates of around 17% compared to between 3% and 10% for placebos given to patients under the age of 65 years. The effect of these drugs on female sexual function is uncertain.

Economic models

Strategies to control hypertension

It is well accepted that there are two complementary approaches to reducing the level of blood pressure in a population.

- The population strategy aims to shift the blood pressure distribution and hence reduce cardiovascular disease across the entire population, even those at lowest relative risk (*23*).
- The high-risk approach is the reduction of blood pressure, usually by pharmacological treatment, of individuals who, by virtue of their level of blood pressure (with or without some additional risk factors), are at the greatest risk of cardiovascular disease. This has important benefits for the individual but may have only a small impact on the population, since most cardiovascular disease occurs outside the high-risk group.

Currently, the most important components of the population approach to blood pressure control include weight reduction, avoidance of excess alcohol, salt restriction, and regular exercise since all these factors have been shown to influence the level of blood pressure. One of the problems with this strategy is that, though constantly advocated, there has been very little attempt to consider realistically how such a strategy is to be adopted within a population, what are the costs of so doing and which strategy, if any, is the most effective for a particular community. Strategies may be very broad-ranging — from food policy legislation and media communication to simple advice delivered by health workers — with clearly very considerable differences in resource implications. Most importantly, strategies must be tailored to the culture of individual populations and the method of health care delivery. At present, there have been disappointing results from one community programme, the North Karelia salt project,[a] the aim of which was to reduce salt intake among the whole population (*20*). Some weak evidence for the benefits from community interventions appears from studies carried out in Belgium (*24*) and Portugal (*25*).

For any country the key economic issue in the high-risk approach is the level of blood pressure at which antihypertensive treatment becomes "affordable". This, in turn, relates to the absolute size of the risk associated with a particular level of pressure (measured for any population by the stroke and coronary heart disease rate), the magnitude of the benefit derived from antihypertensive treatment, the costs of antihypertensive treatment including detection, evaluation and management, and the consequences (economic and quality of life) of not treating. Absolute risk within any population varies with other factors — principally age, sex (mainly for CHD), and the presence of other concomitant risk factors such as smoking and cholesterol. What is "affordable" is a complex issue and depends on the viewpoint (patient, physician, policy-maker, societal), the level of resources, and other competing health care needs. Decisions to spend money on the treatment of hypertension means that the opportunity to spend money elsewhere (from the viewpoint of either the individual or the policy-maker) is lost (opportunity cost), unless the health care budget is increased.

Cost-effectiveness analysis is an economic model in which the output, a cost-effectiveness ratio, expresses the net costs of an intervention relative to its benefits, which is usually measured by the life-years gained from the intervention. Thus, in hypertension cost-effectiveness models require an estimate of the benefit of treatment on the reduction of mortality and disease morbidity, the costs associated with the management of hypertension, and the costs saved from averted morbidity.

There have been several cost-effectiveness analyses of the treatment of hypertension (*26–33*), starting in 1976 with the landmark study by Weinstein & Stason (*26*). This study was performed before the era of the large clinical trials in hypertension, and therefore used estimates from the Framingham model of potential benefits in stroke and coronary heart disease from blood pressure reduction (full benefit model). Very optimistic assumptions concerning blood pressure reduction were made which predicted, using the Framingham model risk coefficients, large reductions in total mortality. Additional analyses modelled variations in benefit including a decrease with age ("age-varying fraction of benefit" model).[b]

[a] The North Karelia salt project is a more recent and much smaller part of the North Karelia project, which aimed at changing a range of lifestyle factors (but at the time, not salt intake) and improving the identification and treatment of subjects with hypertension (*24*).

[b] Weinstein & Stason (*26*) used the "age varying fraction of benefit" to model cost-effectiveness on the assumption that the benefits in reduction of CVD decreased with age. It now appears, as a result of the hypertension trials, that this assumption was incorrect and that the benefit is similar at all ages.

Later cost-effectiveness models were able to utilize the results of meta-analyses of the major clinical trials in hypertension (*1*). These showed more modest reductions in blood pressure (average, 5–6 mmHg) and all the predicted benefit in stroke reduction associated with this change in blood pressure, but only half the benefit for CHD. The magnitude of benefit was similar across all age groups. However, the later cost-effectiveness studies still differed in their estimates of benefit with some studies modelling only benefits in the reduction of strokes (*30, 33*), or benefits only from CHD using the Framingham data (*28*). Nissinen and colleagues used the reduction in mortality from cardiovascular events observed in North Karelia during the programme, compared with the mortality at the start of the programme (*27*). Over a ten-year period the mortality from coronary heart disease declined by 24% in men and 51% in women. The proportion of fatal cardiovascular events attributable to the programme were derived from Framingham. Thus, likely benefits were overestimated in some studies and underestimated in others. The choice of discount rate and whether health costs and benefits are discounted profoundly influences the magnitude of the cost-effectiveness ratios. Costs are invariably discounted to reflect the fact that delays in expenditure reduce the real cost; usually the discount rate for health benefits is matched to that of cost. A low discount rate favours the young compared with the old. Discounting rates of 5% were used in most studies.

In addition to benefits in terms of survival and averted serious events, many cost-effectiveness analyses in hypertension incorporated the effects (utilities) on quality of life. Utilities are valuations of states of health and are usually derived from various probabilistic operations rooted in statistical decision theory. In fact, the studies in hypertension used arbitrary values to estimate the quality of life with antihypertensive treatment, after a stroke or myocardial infarction. In all studies the cost-effectiveness analyses were extraordinarily sensitive to changes in the utility values. Reducing the value for quality of life with treatment side-effects from 0.99 to 0.98 cancelled the life expectancy gains from treatment in most categories of patients in all studies. Changing the utility for stroke from 0.8 to 0.75 halved the ratios in older women.

The results of the cost-effectiveness analyses in hypertension have been reviewed in depth elsewhere (*34, 35*). Although the magnitude of the cost-effectiveness ratios differs considerably between studies (as expected due to different estimates in benefit assumptions), in general most studies are consistent in showing that the gains in cost-effectiveness are greatest where the absolute risk is increased. For example, in men at higher levels of DBP (>100 mmHg) and at older ages (although ratios for age groups over 60 are not available for most studies). The actual values for the ratios were particularly sensitive to the discounting rate and whether health benefits as well as health costs were discounted. In one study, when health benefits were undiscounted, the most favourable ratios were found for the oldest women (>60 years) treated with a diuretic (*33*). Most studies found that treatment with a diuretic was the most cost-effective if all drugs were given the same utility for side-effects (0.99), and assuming that all treatments produced equal benefits on survival.

For example, one study reported the most cost-effective ratios for a man aged 50 with a DBP of 110 mmHg treated with a diuretic (US$ 2588 per life-year gained); ratios at the same age and blood pressure level were US$ 11 172 for the beta-blocker, and US$ 15 035 for an ACE inhibitor (*30*). Edelson and colleagues found the lowest ratios for propranolol from modelling the effects of a rise in cholesterol induced by diuretics (based on Framingham risk coefficients for level of cholesterol), and hence obtaining less benefit from CHD reduction than other antihypertensive agents (*28*). A cost-effectiveness analysis of the MAPHY (Metoprolol Atherosclerosis Prevention in Hypertensives) study also found that cost-effectiveness ratios were more favourable for the beta-blocker compared with the diuretic (*32*), because in this trial (a subgroup of the larger randomized HAPPHY (Heart Attack Primary Prevention in Hypertension) trial) metoprolol significantly reduced CHD. The results of the MAPHY trial are not universally accepted. Trials in the elderly support the use of diuretics; diuretic therapy reduced CHD by the amount predicted from the longitudinal studies in the SHEP study (*36*), while in the MRC trial all the benefits observed (both for stroke and CHD) were in patients randomized to a diuretic while no benefit was observed in those randomized to atenolol (*37*). The interpretation of these latter findings is still open to discussion. Most studies of cost-effectiveness of drugs did not include indirect costs, but in the North Karelia study the impact of inclusion of these was considerable, resulting in very favourable ratios when livelihood losses and averted disability pension costs were included (*20*).

A report from the World Bank, which reviewed the cost-effectiveness of a large range of health care interventions in developing countries, considered the medical management of hypertension as unattractive (*38*). However, the authors acknowledge that these data were based on models from developed countries, and used a range of assumptions which may not be valid in different conditions. Other authors have also concluded that drug treatment is not

affordable in developing countries, based on the estimated costs of treating 50% of all hypertensives aged over 30 years (*7*). Generic drugs would consume between 0.04% (Brazil) and 5% (Bangladesh) of the healh care budget. Trade-name drugs would be at least 10 times as expensive. Although it may well be the case that, for some countries, drug treatment of hypertension is not affordable, we need to be careful in generalizing to all developing countries. Generic diuretics should be considered for those at highest risk (by age and blood pressure level) in countries where the absolute risk of stroke is high (such as Brazil and China) and needs to be seen in the context of the overall economic position of that country, the health care budget and competing health care interventions, and the consequences to society and the individual of not treating. Thus in Brazil, with high stroke rates and a high prevalence of hypertension, a teacher or postman would need to work 0.23 days to pay for one month's supply of diuretics, and an unskilled worker one day (*39*). Equivalent figures for high-income economies such as the USA are 0.03 and 0.06. The average for low-income economies was 4.3 days and 8.5 days respectively, but with very marked variation between low-income countries, in part because of differences between these countries in drug pricing. Clearly, more information in the prevalence and consequences of cardiovascular disease, both in middle-age and elderly subjects, is required from individual developing countries to assist in the formulation of appropriate specific policies.

Opportunities for cost-containment

The costs of management of hypertension include the costs of detection, physician consultations, investigations and drug treatment and the costs of detection and treatment of side-effects of drugs. The relative proportions of these costs vary according to such factors as the need for hospital referral, the number of investigations carried out, and the relative costs of the drugs used. For patients treated by a general practitioner the major costs are those of drug therapy, which accounts for between 60% and 90% of the lifetime costs of treatment (*2, 26, 28, 30*). Medication costs have considerable implications for the "affordability" of treatment at both the individual level and the policy level. In health care systems where patients pay for treatment (either directly or through insurance schemes), it has been shown that for the poorest patients the high treatment cost is one of the contributing factors to poor compliance, and poor hypertension control (*2*). Medication costs differ considerably by type of drug. For example, retail prices of drugs varied across countries in the European community with a 27-fold difference between the cheapest daily treatment for a diuretic, and the most expensive (an ACE inhibitor). Some, but not all, of the difference is explained by the year of entry of the drug onto the market, with more recent ones costing more. There are also considerable between-country variations in drug prices. Pricing mechanisms are complex and represent a tension between the commercial needs of the pharmaceutical companies, especially in the incentive to develop new drugs, and the needs of the health care sector to buy medication at reasonable prices (*2*).

Concern has also been raised over the increase in the number and type of investigations (*40*). For example, 24-hour ambulatory blood pressure recording (ABP) is now commonly used by some doctors in an attempt for better detection and management of hypertension. ABP machines are however relatively expensive (around £1000 in the United Kingdom, at current prices), and it is still not clear what the additional information means and whether it justifies the expense. It has been argued that since blood pressure measured by ABP devices is lower, costs may be reduced since fewer patients need to be treated. Such claims have yet to be validated by data showing that ABPs are as good, or better, predictors of cardiovascular risk as clinic pressures, and in addition whether they are suitable as a basis for treatment decisions. Similar considerations apply to the use of echocardiograms instead of electrocardiograms to determine left ventricular hypertrophy, a useful adjunct when deciding who, in the mild hypertension range, to treat. Although this method may be more sensitive, it is not clear that the extra costs are justified. Investigations also vary by country and physician. In a study comparing practitioners in the USA and England, the U.S. physicians were found to order between 4 and 40 times as many tests as their English counterparts (*41*).

Conclusions

Hypertension-related diseases represent a large economic burden in developed countries, and are becoming increasingly important also in developing countries. The full economic burden is incompletely documented since the attributable risk of hypertension to diseases other than stroke and CHD is uncertain. Vascular dementia and heart failure account for a considerable consumption of resources in old age.

Strategies to control hypertension have economic consequences. This is as true for population-based strategies as it is for the use of antihypertensive drugs. Resources will need to be allocated for these and may differ considerably according to the level and intensity. The most appropriate strategies will vary depending on cultural conditions, and require

evaluation. The World Bank's assumption that population strategies to control hypertension in developing countries are achievable at a small cost needs to be demonstrated. This is not to deny the importance of population strategies, in particular those to reduce excessive alcohol intake, which have benefits across a range of health and social problems. It is likely, but by no means certain, that these strategies will also have benefits in blood pressure reduction. Similarly decisions that drug treatment in developing countries is too expensive require a full appraisal of the burden of stroke, CHD and other hypertension-related diseases which will vary considerably across developing countries.

Results from economic models in hypertension need to be regarded with caution. Two areas are of particular concern: the choice of discount rate and whether health costs and benefits are discounted. Although there is general agreement on discounting costs, it is not necessarily appropriate to discount health benefits. If health benefits are undiscounted, the cost-effectiveness ratios decrease by an order of 13- to 15-fold (*33*). Policy decisions, for example, in developing countries might therefore be profoundly altered. The other area of concern is the methodology to adjust life expectancy with the quality of life (QALY or DALY). Values for quality of life are arbitrary and quite small changes in these, especially for side-effects of medication, have dramatic effects on the cost-effectiveness ratios. In particular a range of important outcomes and ethical issues are obscured by the cost per QALY or cost per DALY summary estimates. Disaggregated data allow decision-makers to consider directly the size of the benefits and costs, e.g., the number of strokes averted or the changes in quality of life parameters with a particular treatment (*42, 43*).

The parameters used in cost-effectiveness analyses in hypertension vary in reliability. Costs are usually known; benefits from blood-pressure lowering can be derived from trials and observational studies but have been differently interpreted. The studies provide some consistency in the results for age, gender and drug group and may therefore be useful when determining policy options within hypertension. In general, older subjects with a diastolic blood pressure of 100–110 mmHg yield the lowest cost-effectiveness ratios. The exclusion of the very elderly, however, increases the uncertainty in comparing cost-effectiveness ratios between older men and women. The choice of treatment is more problematic because of the uncertainty in the quality of life estimates. Leaving this aside, cheaper drugs (diuretics and beta-blockers such as propranolol) are to be preferred to ACE inhibitors, alpha-blockers and calcium channel blockers.

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